



COSMOS

The 2 Deg² HST/ACS Survey

Evolution of Galaxies, AGN, Dark matter
as a function of large-scale structure
and redshift ($z = 0.5 - 4$)



Goals

Principal Science Goals:

- Assembly of galaxies, clusters and dark matter on scales up $10^{14} M_{\text{sun}}$ - well-sampled w/ redshift
- Evolution of galaxy morphology, merging and star formation as functions of LSS environment and redshift
- Reconstruction of dark matter distribution and properties out to $z > 1$
- Evolution of AGN and the relationship between black hole growth and galaxy evolution



Numerous past investigations of:

- LF (z)
- SFR (z)
- Morphology (z)

but studying evolution w/o LSS context !

Merging and interactions drive evolution

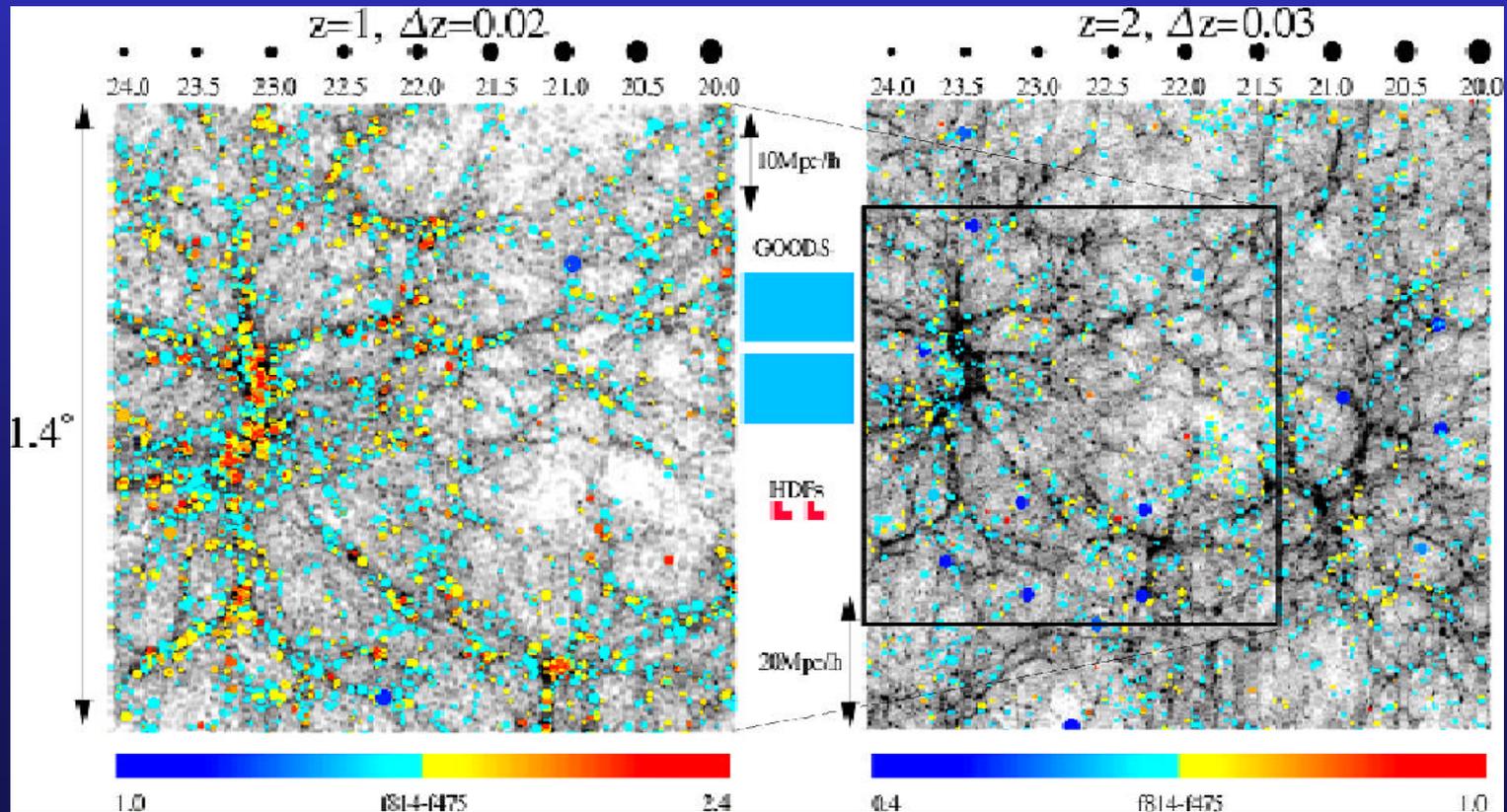
⇒ Designed large-area survey to address this



Area

How large an area?

- $\Delta z = 0.02 \Rightarrow 80$ Mpc depth
- Avoid cosmic variance \Rightarrow image $> 1^\circ$, Frenck et al 2002





Prob. of mass structures
as function of field size:

Observational argument :

$$\langle d \rangle_{L^*} = 7 \text{ Mpc (z=0)}$$

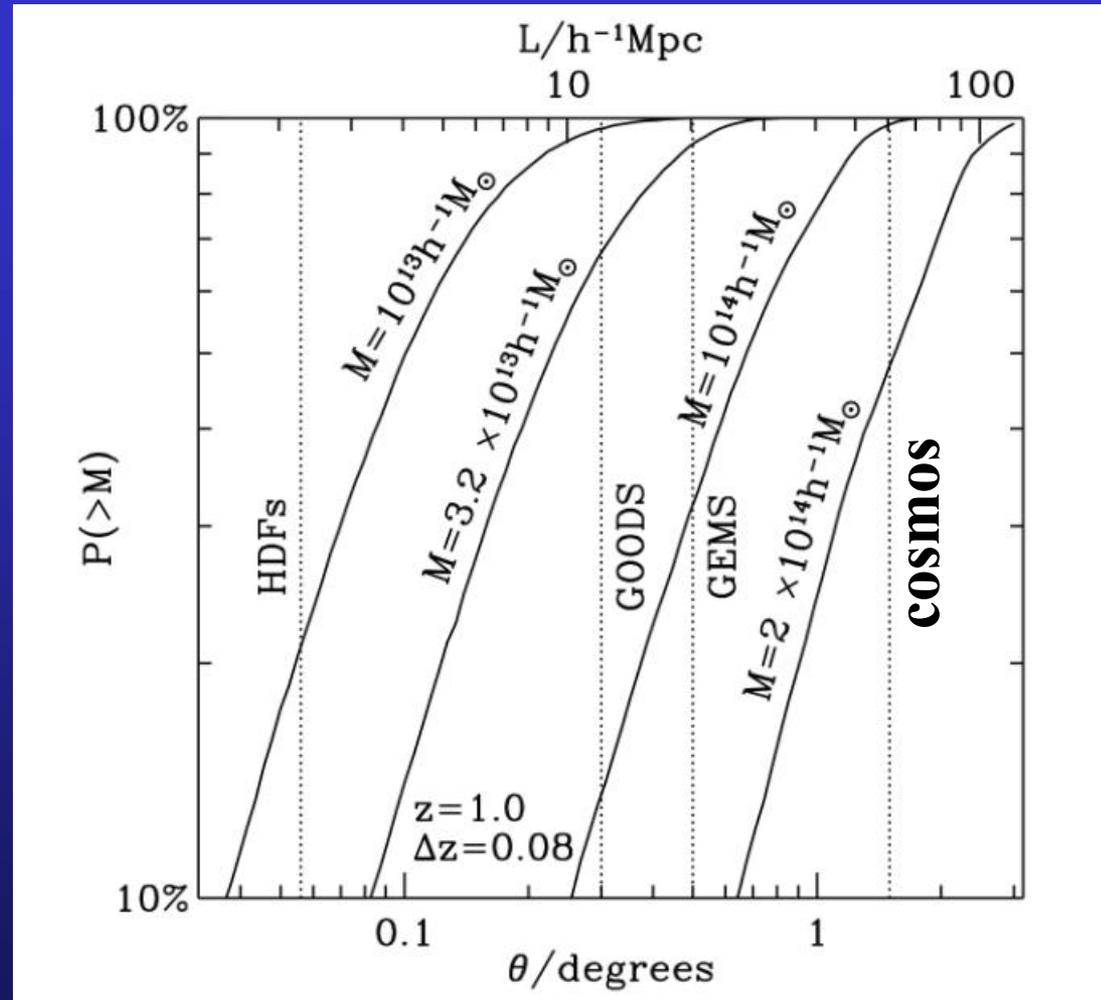
$$\Rightarrow 7' \text{ (z=1)}$$

$$\Rightarrow 4' \text{ (z=3)}$$

$$\Rightarrow 1 L^*$$

for ~ 1000 gal.

$$\Rightarrow \sim 1 \text{ deg}$$



\Rightarrow Need >1 deg to sample all structures



COSMOS -- PI Nick Scoville, 38 team / 59 collaborators

MAJOR CONTRIB.

Roberto Abraham
Justin Alpert
Herve Aussel
Josh Barnes
Andrew Blain
Daniela Calzetti
Peter Capak
John Carlstrom
Chris Carilli
Andrea Cimatti
Andrea Comastri
Marcella Corollo
Emmanuel Daddi
Richard Ellis
Martin Elvis
Amr El Zant
Shawn Ewald

Mike Fall
Alexis Finoguenov
Alberto Franceschini
Mauro Giavalisco
Richard Griffiths
Luigi Guzzo
Lauro Hainline
Gunther Hasinger
Chris Impey
Jean-Paul Kneib
Jin Koda
Anton Koekemoer
Alexie Leauthaud
Olivier LeFevre
Ingo Lehmann
Simon Lilly
Thorsten Lisker
Charles Liu
Richard Massey
Yannick Mellier
Satoshi Miyazaki

Bahram Mobasher
Moire Prescott
Alexandre Refregier
Alvio Renzini
Jason Rhodes
Mike Rich
Dave Sanders
Dave Schminovich
Eva Schinnerer
Nick Scoville
Marco Scodeggio
Kartik Sheth
Patrick Shopbell
Dave Thompson
Neil Tyson
Meg Urry
Yoshi Taniguchi
Ludovic Van Waerbeke
Paolo Vettolani
Simon White
Lin Yan



Strategy

Survey design:

- 2 deg² to cover largest LSS at $z \sim 1 - 2$
- HST/ACS (4096² pix) - 600 pointings:
 - 1 orbit (2000s) / pointing, 4 dithered exp's
 - F814W ("wide I") \approx SDSS i+z
 - 50 mas/pixel \Rightarrow 10¹⁰ pixels total ($\sim 10^3 - 10^4$ pix / L* galaxy)
- high sensitivity (I > 27 mag, 10 σ)
 - morphology of L* galaxies for $z < 2$
- sensitivity + area:
 - 10⁶ galaxies
 - also enough area to cover unusual objects at higher z
- equatorial (10^h00^m, +2°12') \Rightarrow multi- λ obs from all tel.

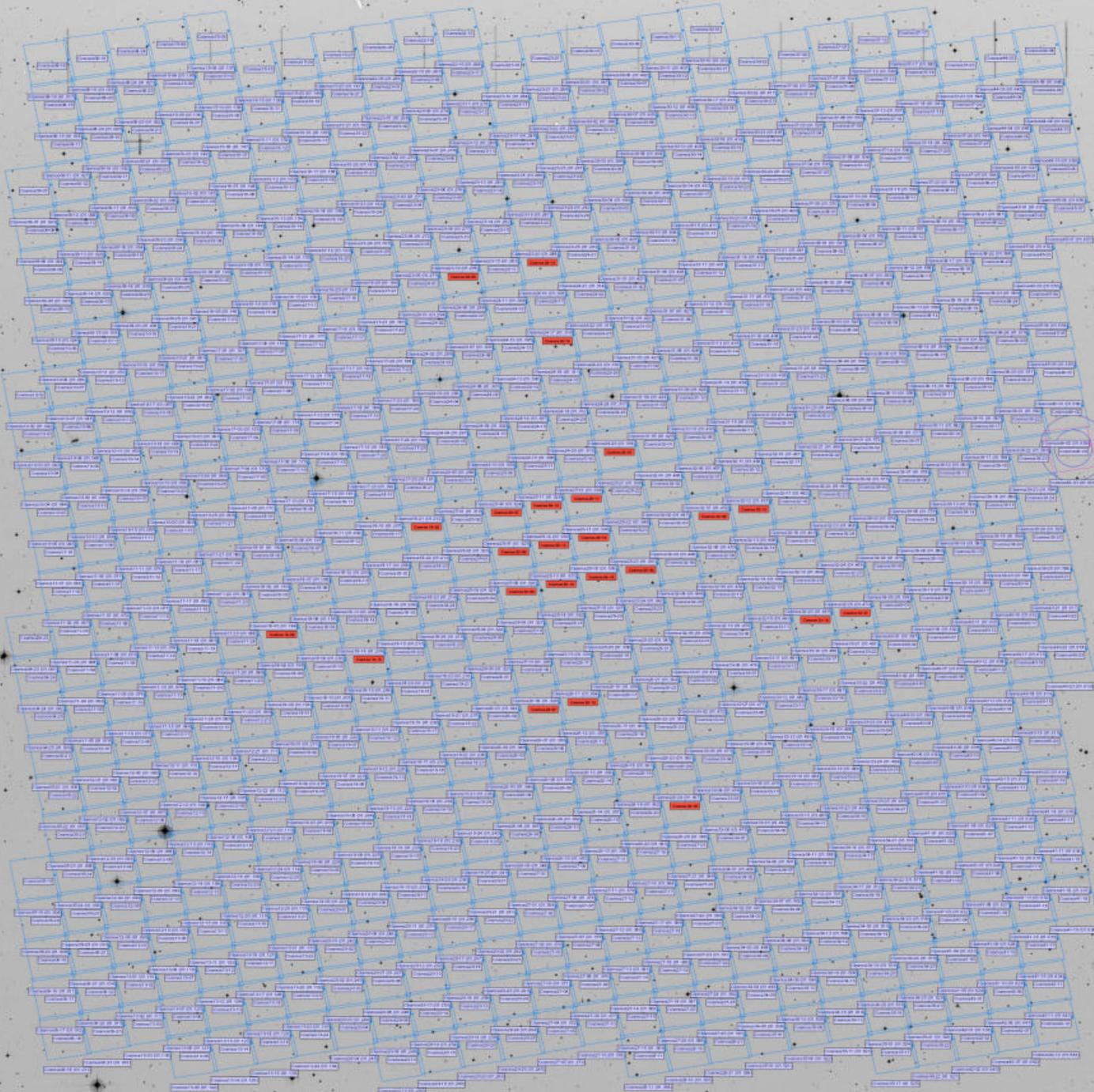


Multi- λ dataset

Multi- λ COSMOS Data

Data	Bands, λ , Res.	AB mag 5σ pt. src	status	Investigators/Time
HST-ACS	814I	27	U	C12-13 581 o
HST-ACS	475g	27	U	C12 9 o
HST-NIC3	160W	22.9(5% area)	U	C12-13 590 o
HST-WFPC2	300W	26.4	U	C12-13 590 o
Subaru-SCam	B,V, r', i, z'	27,27,, 27,26, 25	U	Taniguchi <i>et al.</i> 10 n
Subaru-SCam	NB, 12Ia	25	U/P	Taniguchi <i>et al.</i> 20 n
CFHT-Megacam	u*	27	U	Sanders <i>et al.</i> 24 hr
CFHT-Megacam	u, i*	26	U	LeFevre <i>et al.</i> 12 hr
CFHT-LS	u-z		U	Deep LS Survey
NOAO	K_s	21	U	Mobasher <i>et al.</i> 10 n
CFHT	K	23 ($9 \times 9'$)	U	Sanders <i>et al.</i> 3 n
UH-88	J	21	U	Sanders <i>et al.</i> 10 n
GALEX	FUV, NUV	26.1, 25.8	U	Schminovich <i>et al.</i> 200 ks
XMM-EPIC	0.5 – 10 keV	10^{-15} cgs	U	Hasinger <i>et al.</i> 1.4 Ms
CXO	0.5 – 7 keV	pointed	F	Elvis <i>et al.</i>
VLT-VIMOS sp.	(R=200)	$\#=18000$ ($I_{AB} < 23$)	U	Kneib <i>et al.</i> 68 hr
VLT-VIMOS sp.	(R=200)	$\#=72000$ ($I_{AB} < 25, z \geq 0.8$)	F	Kneib <i>et al.</i> 510 hr
Mag.-IMAX sp.	(R=3000)	$\#=2000$	U	McCarthy 5 n
Keck/GEMINI sp.	(R=5,000)	$\#=4000$ ($I < 24$)	F	Team Members
Spitzer-MIPS	160, 70, 24 μ m	17, 1, 0.15 mJy (5σ)	F	Sanders <i>et al.</i>
Spitzer-IRAC	8, 6, 4.5, 3 μ m	11, 9, 3, 2 μ Jy (5σ)	F	Sanders <i>et al.</i>
IRAM-30m	1.2 mm	1 mJy ($20 \times 20'$)	U	Bertoldi <i>et al.</i> 94 hr
CSO-Bolocam	1.1 mm	3 mJy	U	Blain <i>et al.</i> 40 n
VLA-A	20cm	24 μ Jy (1σ)	U	Schinnerer <i>et al.</i> 10 hr
VLA-A/C	20cm	8 μ Jy (1σ)	F	Schinnerer <i>et al.</i> 260 hr
SZA(full field)	9 mm	S-Z to $2 \times 10^{14} M_{\odot}$	F	Carlstrom <i>et al.</i> 2 mth

Status: U \rightarrow underway (done or scheduled time); F \rightarrow future proposal; P \rightarrow this proposal



As of **1°**
18 May 2004:

**THE LARGEST
HST FIELD!!!!**

270 orbits:

- 261 F814W (I)
- +9 F435W (g)

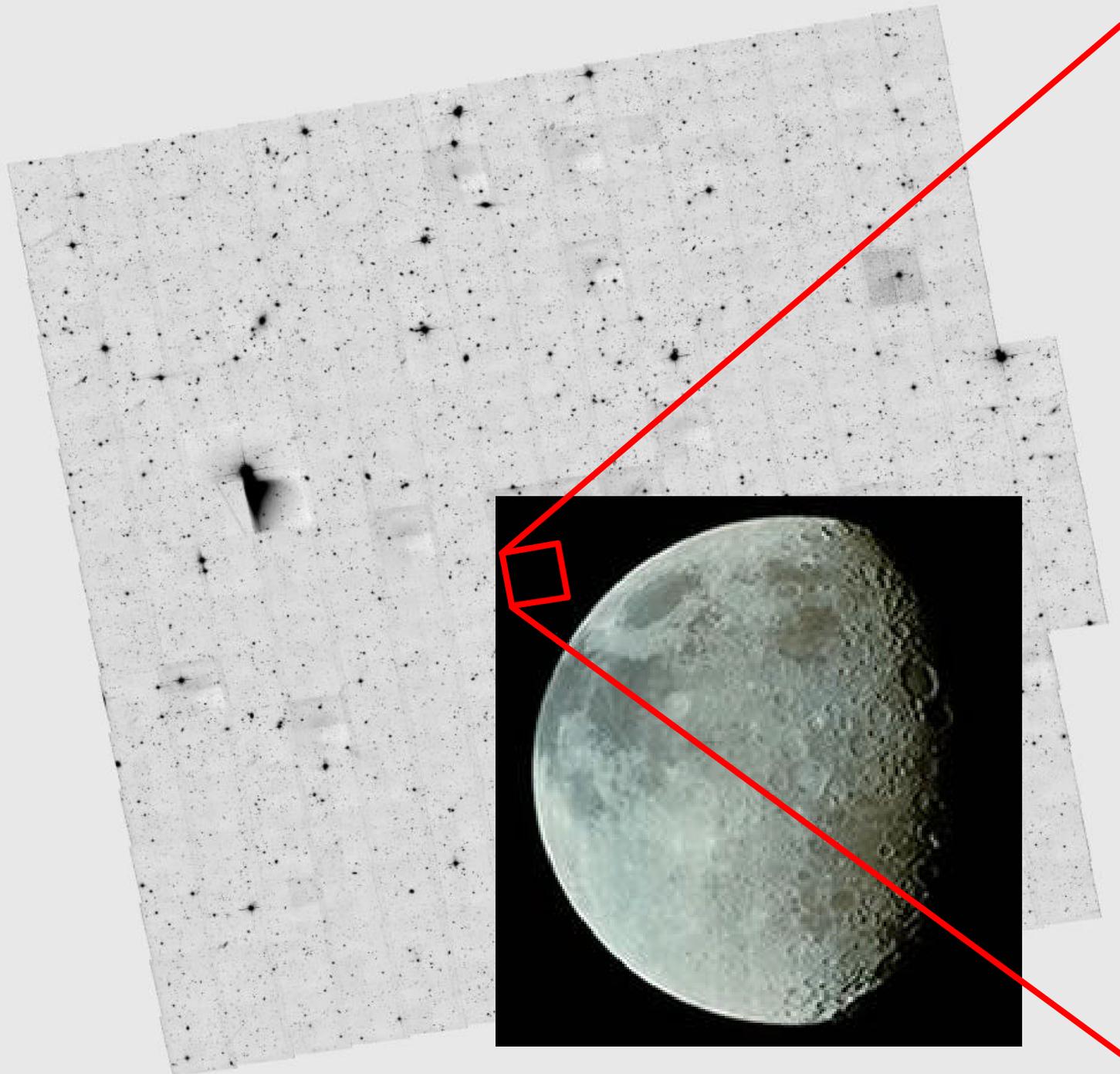
Total # pixels:

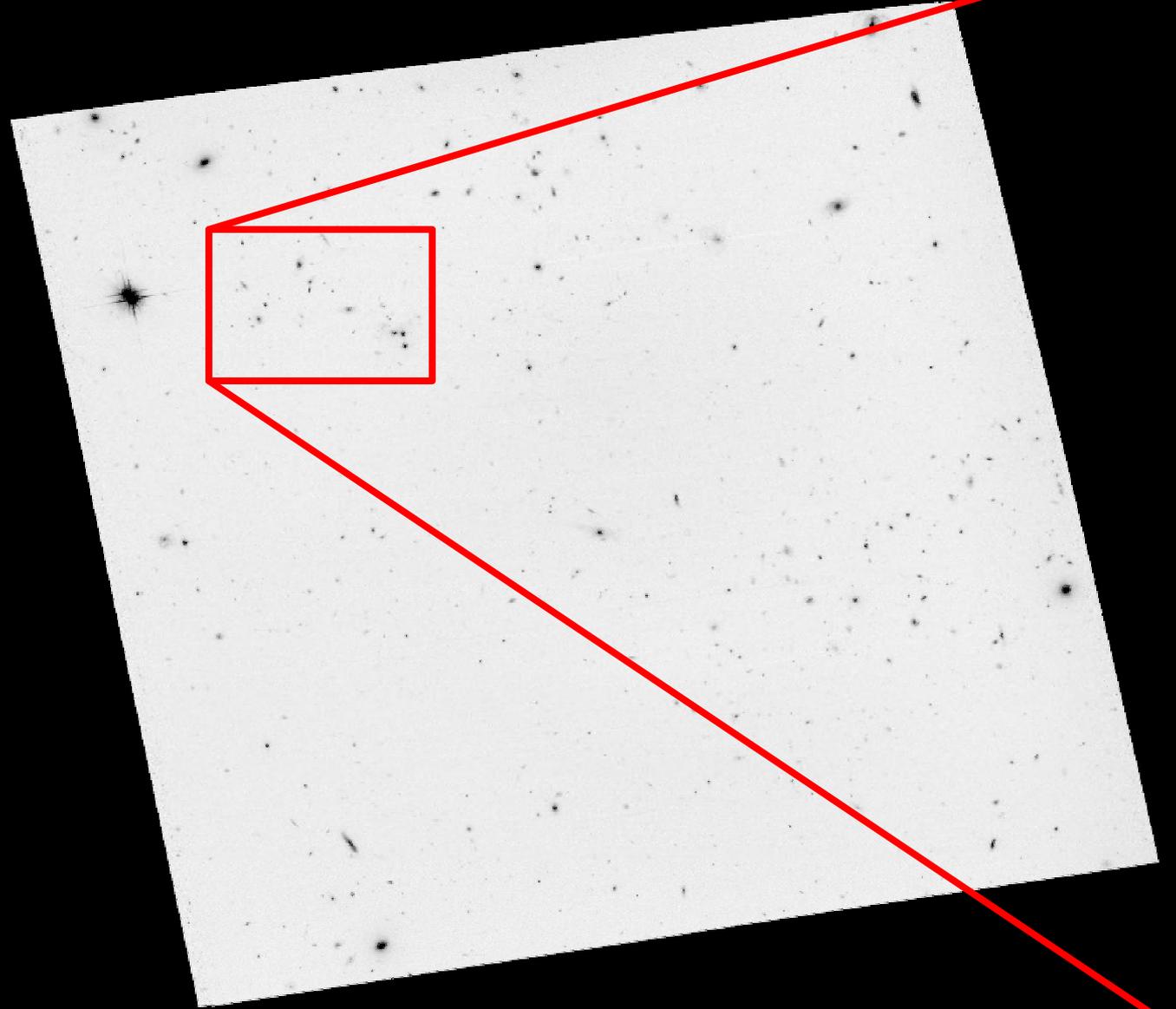
$\sim 4.5 \times 10^9$

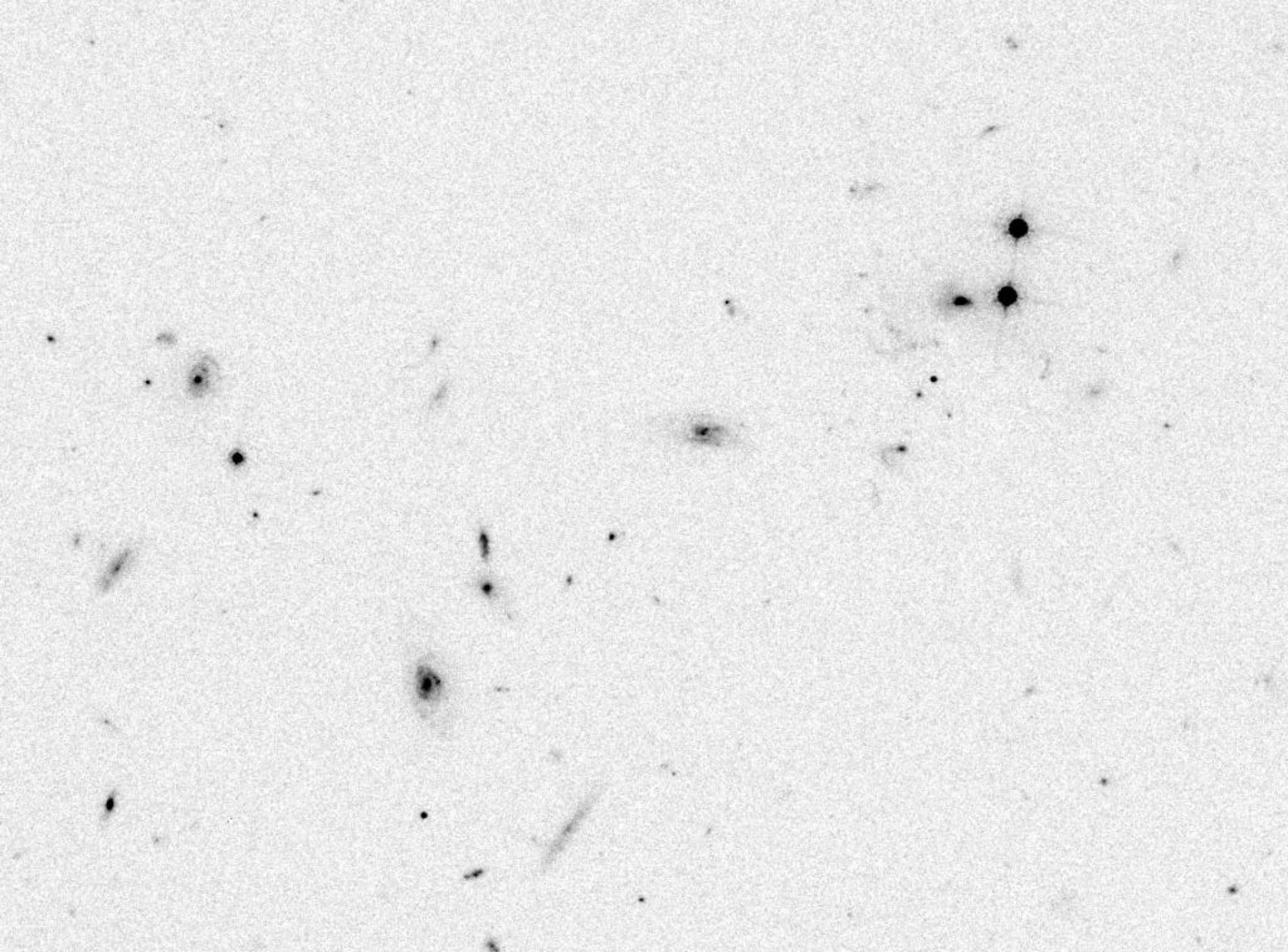
Coverage:

I: 1.0 °

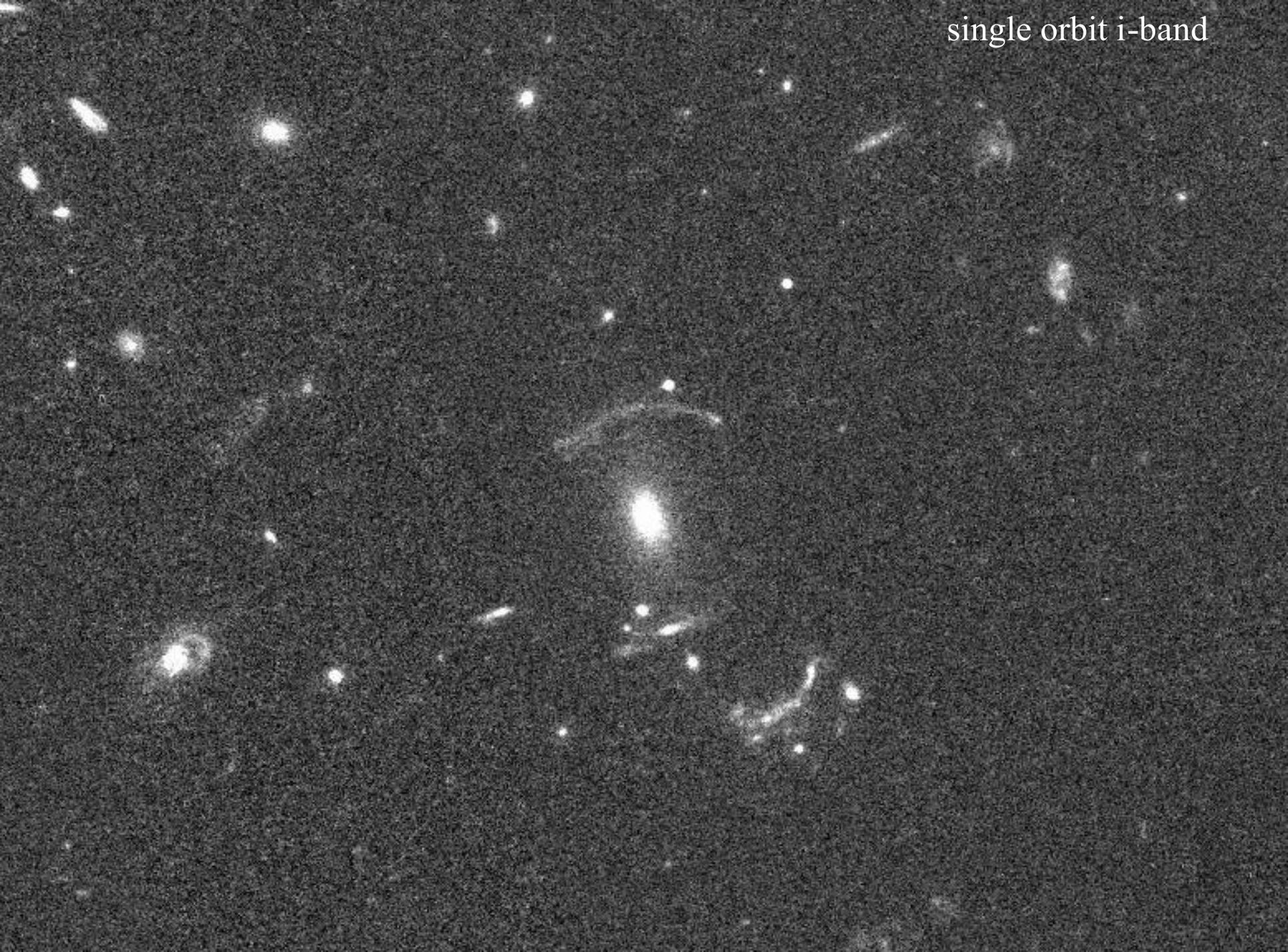
g+I: 100 '







single orbit i-band





Subaru

1.5x1.5 deg

0.7" res.

(Taniguchi)

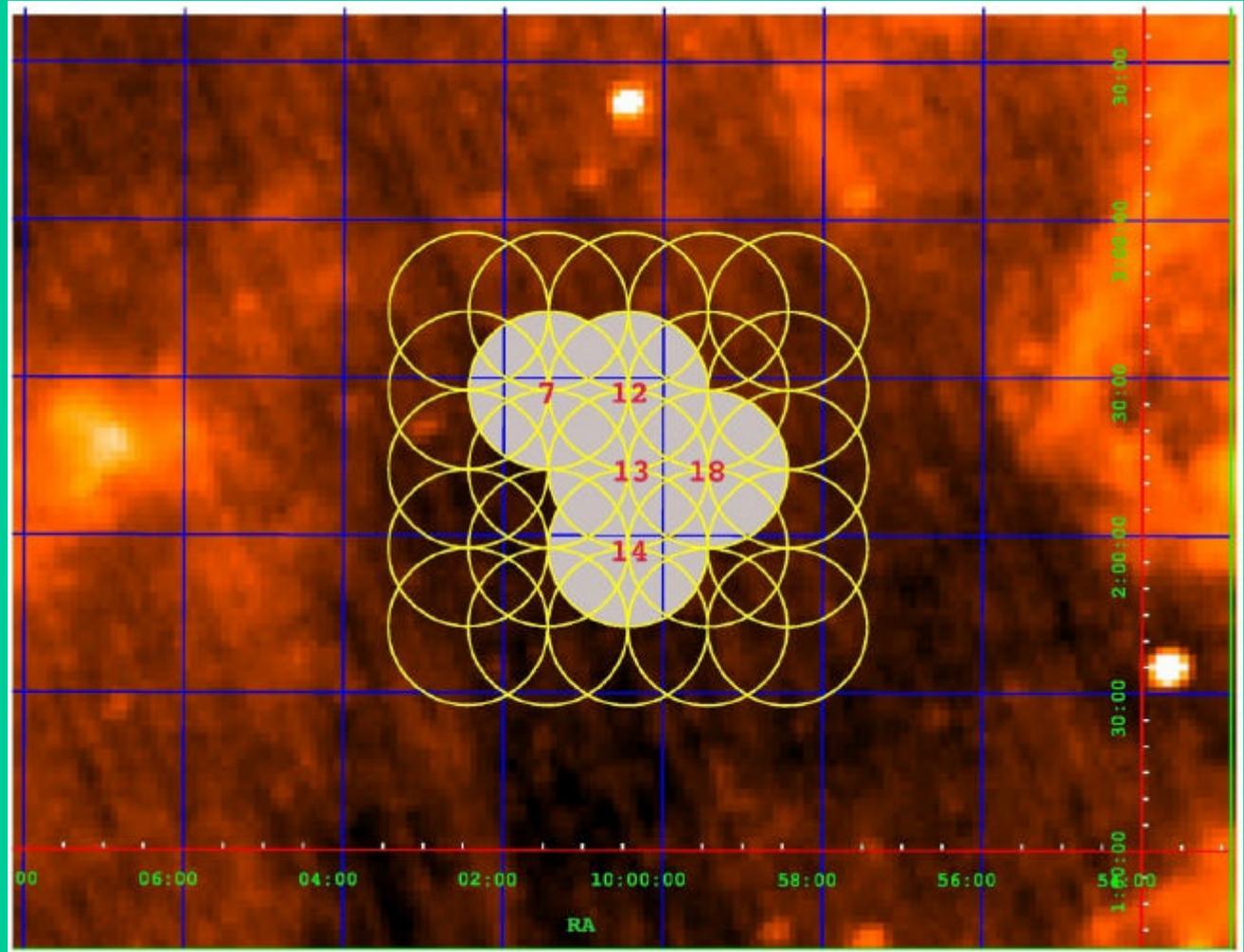




XMM -

0.5 -- 10 keV

2003/04 -
1.4 Msec total
PI: G. Hasinger





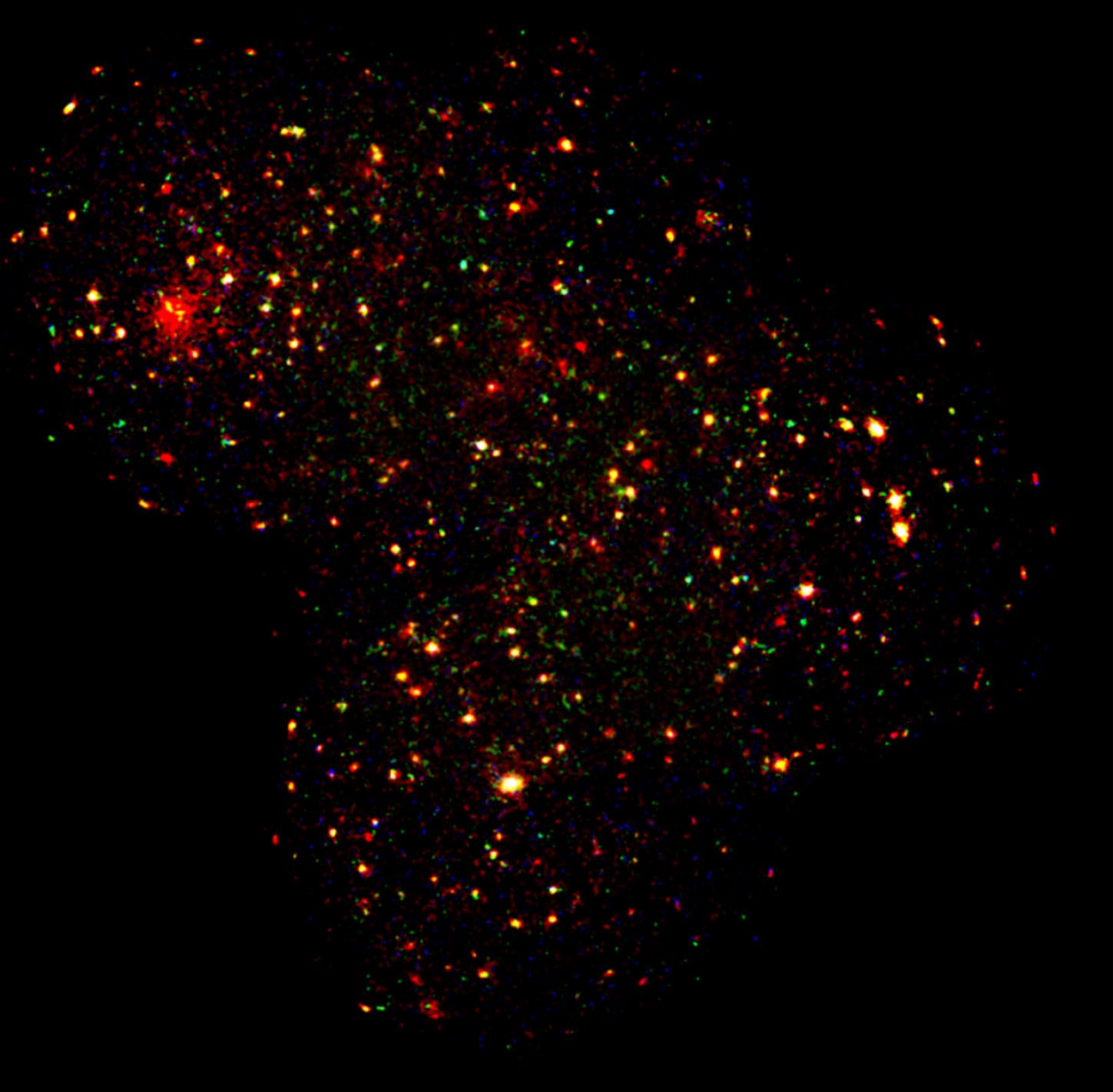
XMM

red --
0.5-2 keV

green --
2-4.5 keV

blue --
4.5-
10keV

**339 sources
detected**



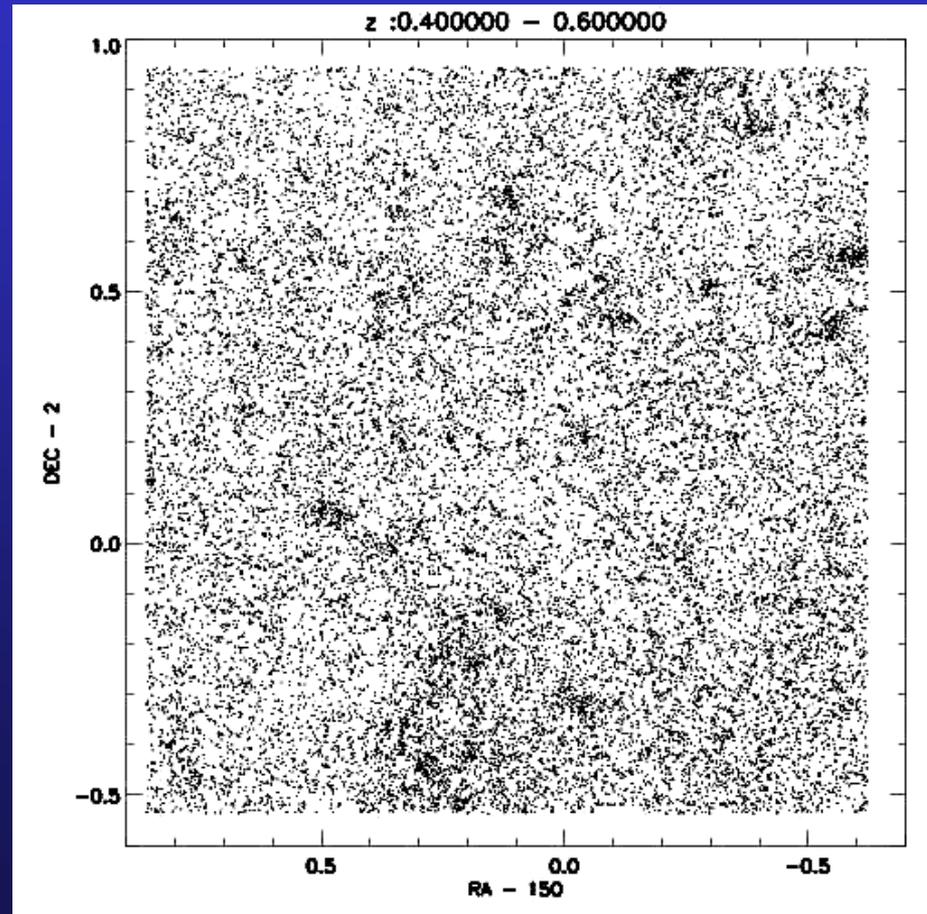


Prelim. LSS results

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Anton Koekemoer, STScI
Widefield Imaging from Space, Berkeley, 18 May 2004

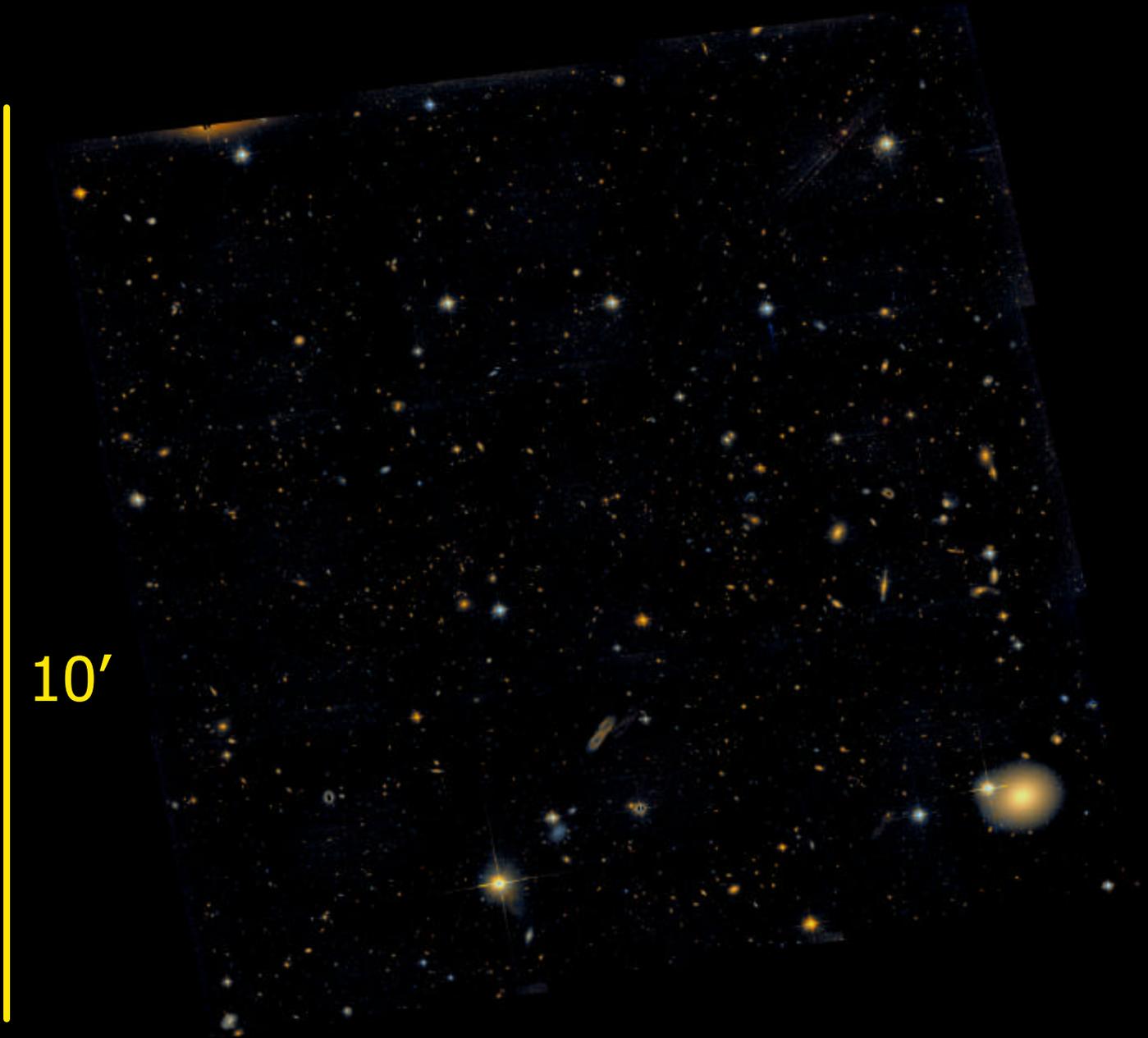
Using Subaru phot-z's (Scoville, Mobasher et al)



The 2-band
dataset:
3x3 g+I
AB~27 (10s)

100 sq '
6x10⁸ pixels
(scale=0.5;
25 mas/pix)

10'







Summary

Status:

- COSMOS is now the largest contiguous HST field ever observed - $1^\circ \times 1^\circ$ (4x larger than GEMS..sorry GEMS!)
- Cyc 12 in hand (270 orbits), total 600 by end Cyc 13

Properties:

- F814W to AB ~ 27 (10σ)
- Full dataset equivalent to a few SNAP pointings
- 2 million galaxies, 3400 X-ray AGN, 120 clusters

For all information see:

<http://www.astro.caltech.edu/~cosmos/>

